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ICHTHYOLOGY.—*A key to the species and subspecies of the cyprinodont genus* Fundulus *in the United States and Canada east of the continental divide.*

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There has not been a complete, reliable guide for the identification of the species and subspecies of the fishes of the genus *Fundulus*. The genus is found in more than half of the United States, in southeastern Canada, Bermuda, northern Cuba, and certain coastal areas of Mexico. Only in the United States and Canada east of the Continental Divide, the area covered by this key, and in Mexico (?) do two or more species occur sympatrically, so far as known.

Of the 33 currently recognized species and subspecies, 7 do not occur in the area covered by this key. Two of these, *Fundulus grandissimus* Hubbs (1936: 209) and *Fundulus persimilis* Miller (1955: 13), have been collected only in the Mexican state of Yucatán. Two are insular subspecies, *Fundulus heteroclitus bermudae* of Bermuda and *Fundulus grandis saguanus* Rivas (1948) of the north coast of Cuba. The remaining three are allopatric on the Pacific coast. They are *Fundulus p. parvipinnis* from Morro Bay, Calif., south along the coast to the area occupied by the next form; *F. p. brevis* in Magdalena Bay, Baja California; and *Fundulus lima* in fresh-water springs at San Ignacio, Baja California. All but one of these 7 forms are related to *Fundulus heteroclitus* and *F. grandis*. *Fundulus persimilis* is closest to *F. similis*.

The center of speciation may have been in the southeastern United States, where 20 species are now found. *Fundulus* occurs in habitats ranging from salt marshes and the ocean to upland streams, but it is usually found in relatively quiet water.

I wish to thank Dr. Edward C. Raney for his generous assistance and encouragement in this study. The work was completed at Cornell University in 1954 as a master's thesis, which may be consulted in the Cornell University Library for additional details.

MATERIALS AND METHODS

This study was based on counts and measurements made on over 1,500 specimens in the Cornell University fish collection. In addition, 31 specimens of *Fundulus notti dispar* were examined on loan from the University of Michigan Museum of Zoology, for which I thank the curator, Dr. Reeve M. Bailey.

External characters have been used exclusively. The descriptions of coloration are based entirely on preserved specimens. For a few species counts were taken from published accounts by authors who used the methods of counting described by Hubbs and Lagler (1947). These instances have been acknowledged in the key in order to remind the reader of the differences in the methods of counting used by these authors, which result in one fewer ray in the dorsal and anal fins and from one to several more scales in the lateral line. Numbers in parentheses in the text of the key represent the known range or extreme values not often encountered. It is frequently necessary to know the sex of a specimen since all of the species show some degree of sexual dimorphism. This can be determined in the adults of all species by the presence of a pouch covering the anterior base of the anal fin of females and by its absence in males. The pouch carries the ovi-

duct down the first ray of the anal fin and is of various degrees of prominence depending on the species. For some species the key is based on a relatively small number of specimens; consequently, some specimens which do not fit the descriptions exactly will undoubtedly be discovered.

Dorsal, *anal*, and *pectoral* rays were counted at their bases; the last two rays were not counted as one. *Lateral-line scales* were counted according to the method of Hubbs and Lagler (1947: 11) except that the most anterior scale counted was the one in which the center of the exposed field of the scale lay exactly on, or just posterior to, a vertical line through the upper extremity of the gill slit. *Scales around the caudal peduncle* (often, but not necessarily, the least count) were counted vertically half way between the posterior bases of the dorsal and anal fins and the anterior limits of the upper and lower procurrent caudal rays. *Scales above the lateral line* were counted in front of the dorsal fin from the first scale above the lateral line of one side, in a vertical row, to and including the last scale above the lateral line of the other side. *Mandibular pores* correspond to pores W, X, Y, and Z of Gosline (1949: pl. 2). Most species of *Fundulus* have four on each side.

Head length was measured with dividers from the bony opercle at its most posterior projection to the tip of the snout, with the mouth in its normal closed position. *Snout length* was taken on the midline from the tip of the snout to the anterior bony rim of the orbit, with the point of the dividers inserted to the bony interorbital septum. *Postorbital head length* was measured from the posterior fleshy rim of the orbit to the posterior edge of the bony opercle at a level with the upper base of the pectoral fin. The *orbit* was measured horizontally with dividers between the fleshy rims of the orbit. Other measurements and counts were made according to the methods of Hubbs and Lagler (1947: 8–15).

KEY TO THE SPECIES AND SUBSPECIES OF FUNDULUS IN THE UNITED STATES AND CANADA EAST OF THE CONTINENTAL DIVIDE

1. Gill slit restricted; upper end of gill slit opposite or only slightly above upper base of pectoral fin, relatively far from posterodorsal corner of opercle.....2

   Gill slit normal, not restricted; upper end of gill slit relatively far above upper base of pectoral fin, at or anterior to posterodorsal corner of opercle.....5

2. (1) Vertical bars absent in both sexes; D. 13–16; A. 13–19.....20

   Vertical bars present in both sexes except in females of *F. luciae*, for which D. 8; A. 10 3

3. (2) Dorsal rays 8; anal rays 10; lateral-line scales 31–32; smallest species of *Fundulus*; females plain; males vertically barred and with a black ocellus on last few rays of dorsal fin; dorsal over anal in females, behind in males; Atlantic coast, North Carolina to Long Island.....*F. luciae*

   Dorsal rays 11 or more; anal rays 13 or more; lateral-line scales 41–64 (Hubbs, 1926: 15); dorsal in advance of anal; 11–21 vertical bars 4

4. (3) Lateral-line scales 52–64 (Hubbs, 1926: 15); dorsal rays 15–17; anal rays 15–16; Wyoming and South Dakota to northern Texas and New Mexico.....*F. kansae*

   Lateral-line scales 41–49; body more robust; eye larger (Hubbs, 1926: 15); upper Brazos, Colorado, and Pecos drainages of Texas and New Mexico and the Llano Estaçado of northwestern Texas.....*F. zebrinus*

5. (1) Dorsal rays 9 or less.....6

   Dorsal rays 10 or more.....14

6. (5) Anterior insertion of dorsal behind (or over) anterior insertion of anal; dorsal rays fewer than anal rays.....7

   Anterior insertion of dorsal before or over anal; dorsal rays more than or equal to anal rays.....14

7. (6) Lateral, longitudinal band single, median, broad (several scale rows in width), brown or black, extending from tip of snout and chin through eye to base of tail; D. 8–12; A. 11–13; pectoral 14 to 15; lateral-line scales 32 to 36.....8

   Lateral, longitudinal bands either absent or several (about 5–9), each the width of one scale row or less, not extending onto head 9

8. (7, 14) Spots on sides of back conspicuous, discrete, black; lateral band of females even-edged; vertical bars in males not prominent; spots on vertical fins irregular in size, shape, and distribution, often very small, like finely ground pepper; young conspicuously black about base of anal fin

   F. olivaceous

   Spots on sides of back inconspicuous, diffuse, olive-brown; lateral band of females strongly serrated; vertical bars in males prominent, sometimes disrupting the longitudinal band; spots on vertical fins large, often arranged in rows; very fine spots often absent; young with pigment about anal fin brownish and inconspicuous.....*F. notatus*

9. (7) Blackish subocular blotch present on

cheek; caudal fin oboval, almost pointed; about 5–9 lateral, longitudinal, dark lines in females (except in *F. n. notti*); vertical bars strong in males ..... *F. notti* 10

Blackish subocular blotch absent; cheek lighter than rest of head; caudal fin square or round; no lateral, longitudinal dark lines on either sex; vertical bars usually not strong 12

10. (9) Scales around caudal peduncle 16–17 (16–19); Ochlockonee River of western Florida eastward and northward in Atlantic coast drainages to southern Virginia *F. notti lineolatus*

Scales around caudal peduncle 20 (18–20) 11

11. (10) Anal rays usually 10; dark, longitudinal lines of females not outstanding; light rows between them crossed by the dark edge of each scale; in large females all body coloration virtually absent except the dark spots in the scale centers; Gulf coast drainages from New River of western Florida to Texas *F. notti notti*

Anal rays usually 11; dark longitudinal lines of females prominent; light rows between them virtually clear; Mississippi Valley *F. notti dispar*

12. (9) Sides of body with 12–30 round spots the size of a scale or less, often arranged in two rows lying along or above the lateral line, blended in some specimens to form short, indistinct, vertical bars; scales around caudal peduncle usually 16; top of head flat or slightly concave in front of eyes; snout sharp ..... *F. jenkinsi*

Sides of body rarely spotted; if so, spots in the nature of dense, black irregular blotches randomly scattered over body and fins; vertical bars distinct in most males, absent in females (except *F. cingulatus*); scales around caudal peduncle usually 20; top of head flat or slightly convex in front of eyes 13

13. (12) Total mandicular pores 6; scales above lateral line 9 (8–11); dorsal rays 8 (7–9); anal rays 10 (11); lateral-line scales 29–30 (28–33); snout short and rounded, length 1.6–2.2 into postorbital head length; anal fin of adult males usually longer than head; small, light, "pearl" spots on sides of body absent; vertical bars on sides of males and females narrow, straight, with distinct edges, usually 12 or more ..... *F. cingulatus*

Total mandibular pores 8; scales above lateral line 10–11 (9–12); dorsal rays 9 (8–10); anal rays 11 (10–12); lateral-line scales 31–33 (30–34); snout longer and more pointed, length 1.4–1.7 into postorbital head length; anal fin of adult males usually shorter than head; small, light, "pearl" spots present in females, irregularly scattered over sides of body; vertical bars on sides of males wider, often wavy and irregular, edges often indistinct, usually less than 12 .... *F. chrysotus*

14. (5, 6) Lateral, longitudinal band single, median, broad (several scale rows in width), brown or black, extending from tip of snout and chin through eye to base of tail; D. 8–12; A. 11–13; pectoral 14 to 15; lateral-line scales 32–36 8

Lateral, longitudinal bands, if present, not extending onto head or snout, often more than one 15

15. (14) Lateral-line scales 40 or more; or if less (as sometimes in *F. diaphanus*) caudal peduncle depth into distance from caudal base to anterior insertion of dorsal 3.4 or more, a slender species with vertical bars in both sexes 16

Lateral-line scales 39 or less; caudal peduncle depth into distance from caudal base to anterior insertion of dorsal 3.2 or less 22

16 (15) Dorsal rays 12 or less 17

Dorsal rays 13 or more 19

17. (16) Caudal peduncle depth into distance from caudal base to anterior insertion of dorsal 3.3 or more; A. 11–14; sides with crossbars in both sexes 21

Caudal peduncle depth into distance from caudal base to anterior insertion of dorsal 3.2 or less; A. 9–12 18

18. (17) Range: coastal, in fresh or brackish water, Chesapeake Bay to Texas; a black ocellus or spot between last few rays of dorsal fin of female; vertical fins never narrowly black-edged; cheek dark or coarsely speckled; both sexes vertically barred (females from Gulf Coast sometimes spotted or longitudinally streaked); see also first halves of couplets 30 and 25 32

Range: reported only from the lower Tennessee River drainage of Alabama and Tennessee; ocellus not present on dorsal; vertical fins often narrowly black-edged; cheek clear or coarsely speckled; vertical bars absent; males with interrupted white lines following centers of scale rows; females with fine, dark, broken lines following centers of scale rows; D. 10–11; A. 10–11; lateral-line scales about 42 ..... *F. albolineatus*

Range: Oklahoma to Wyoming and South Dakota; ocellus not present on dorsal; vertical fins not narrowly black-edged; cheek clear or finely speckled only immediately below eye; vertical bars absent; see also couplet 26 ..... *F. sciadicus*

19. (16) Vertical bars absent on the sides of both sexes; males with light lines following centers of scale rows, alternating with dark lines running between scale rows, sometimes irregularly broken or dashed; females with fine, dark, dashed lines following centers of scale rows, or irregularly speckled with black; dorsal behind or over anal; A. 13–19; snout short 20

Vertical bars usually present on the sides of both sexes, sometimes fused into a short longitudinal band on caudal peduncle;

dorsal before or over anal; A. 10–15; snout long.....21

20. (2, 19) Anal rays 14–15 (95 percent separation), (13–16); scales around caudal peduncle 19–23; orange or dark flecks scattered randomly over sides of body or loosely arranged in broken, irregular, longitudinal lines; found only in Alabama River System
F. stellifer

Anal rays 16 (95 percent separation), (15–19); scales around caudal peduncle 16–20; orange or dark flecks arranged in orderly parallel lines following scale rows; not found in Alabama River System.....*F. catenatus*

21. (17, 19) Found in Florida only; D. 13–20; A. 10–15; pectoral 18 to 21; lateral-line scales 49–61; scales around caudal peduncle 24–29
F. seminolis

Found only in Lake Waccamaw, N. C.; D. 13–15; A. 10–12; pectoral 15 to 18; lateral-line scales 54–64; scales around caudal peduncle 19–25 (range and counts from Hubbs and Raney, 1946: 12–17)
F. waccamensis

Found from South Carolina north to Maritime Provinces (*F. d. diaphanus*) and from the eastern Dakotas to western New York (*F. d. menona*), with intergrading populations between. *F. d. diaphanus:* lateral-line scales 45–49 (40–55); D. 13–14 (12–15); A. 11–12 (10–13); pectoral 16 to 17 (15 to 19). *F. d. menona:* lateral-line scales 40–44 (35–49); D. 11–13 (10–14); A. 10–11 (9–12); pectoral 14 to 15 (13 to 17). For more detailed separation of subspecies see Hubbs and Lagler (1947: 77–78), from which the above information and counts were taken.....*F. diaphanus*

22. (15) Dorsal behind (or over) anal; dorsal rays fewer than anal rays.....23

Dorsal before or over anal; dorsal rays more than or equal to anal rays.....27

23. (22) Sides of body with 12–30 round spots the size of a scale or less, often arranged in two rows lying along or above the lateral line, blended in some specimens to form short, indistinct, vertical bars; scales around caudal peduncle usually 16; top of head flat or slightly concave in front of eyes; snout short and sharp; Texas to western Florida
F. jenkinsi

Sides of body not spotted as above; scales around caudal peduncle usually 20; snout less sharp.....24

24. (22) A fine dark line running from beneath eye to, or almost to, corner of mouth (usually absent in young); a thicker line on the same level on the opercle, distinct in young (sometimes blurred or absent in adults); found only in the Piedmont region of North Carolina; see couplet 27 for additional description.....*F. rathbuni*

A fine, dark line from beneath eye to corner of mouth absent; no line on opercle, as described above; males vertically barred; females variously colored but not with dark speckling.....25

25. (24) Cheek below eye dark or coarsely dotted; dorsal before or over anal; dorsal rays commonly more than anal rays; a dark ocellus on last few rays of dorsal in females; coastal, Chesapeake Bay to Texas; see first half of couplet 30 for additional description.....32

Cheek below eye clear or only finely dotted; dorsal behind (or over anal); dorsal rays commonly fewer than anal rays; ocellus on dorsal absent (except very rarely when also found on body).....26

26. (25) Dorsal rays 8–10; anal rays 11 (10–12); lateral-line scales 30–34; males with dark vertical bars; females with small light spots irregularly scattered on sides; both sexes occasionally occur with heavy dark blotches anywhere on body or fins; see couplet 13 for additional description.....*F. chrysotus*

Dorsal rays 11–12 (10); anal rays 13 (12–14); lateral-line scales 28–41; both sexes plain colored or with broad, faint lateral stripe; a Plains species, from Oklahoma to Wyoming and South Dakota.....*F. sciadicus*

27. (22) A fine, dark line running from beneath eye to, or almost to, corner of mouth, usually absent in young; a thicker line at the same level on the opercle, distinct in young (sometimes blurred or absent in adults); males plain with few if any spots on body, each scale with dark outline; females with dark spots and flecks irregularly scattered on sides, rarely forming vague bars or lines; fins usually unspotted; D. 11–14; A. 10–12; pectoral 15 to 18; lateral-line scales 33–38; found in the Piedmont region of North Carolina.....*F. rathbuni*

A fine, dark line from beneath eye to corner of mouth absent; line on opercle (as described above) also absent; males vertically barred; females variously colored.....28

28. (27) Snout pointed, long, a little less than 2 times eye in side view (except in young), distinctly below a horizontal line through middle of eye (except in young); orbit into postorbital head length from 2.0 in small adults to 2.7 in large adults; dark vertical bars when present narrower than two-thirds the interspace; a silvery sheen on sides of young and adults of both sexes.....29

Snout round, short, a little over one times eye in side view, usually on a level with or above a horizontal line through middle of eye; orbit into postorbital head length from 1.5 in small adults to 2.0 in large adults; dark vertical bars in males generally broader than or equal to interspaces; bars variable in females; silvery sheen not conspicuous on sides.....30

29. (28) Dorsal rays 14–15 (12–16); lateral-line scales 33–35 (32); adult females with one to several dark longitudinal lines on sides;

head length into standard length 3.0–3.3 (2.9) Florida to New Hampshire. . *F. majalis*

Dorsal; rays 12–13 (11–14); lateral-line scales 30–32 (33); females lack dark longitudinal lines on sides; head length into standard length 2.7–2.9 (2.7–3.1); Florida to Texas *F. similis*

30. (28) Anal rays 10 (9–11); pectoral rays 17 (18) or less; lateral-line scales 34–37 (32–45); females with an ocellus or one or two black blotches on last few rays of dorsal fin, remainder of dorsal fin usually unmarked; pouch at anterior base of anal very small or lacking in females, higher on first ray of spread anal fin than on any succeeding ray, usually one-tenth length of depressed anal or less; back mottled with dark spots; all fins much shorter in both sexes; caudal fin length 5 to 6 into standard length of adults over 35 mm, 4.4 to 5.0 in young; Chesapeake Bay to Texas.....32

Anal rays 11 (10–12); pectoral rays 18 (17) or more; lateral-line scales 31–34 (35); females with dorsal fin clear, no ocellus or dark blotch; easily separated by the anal pouch, which is shorter on the first ray than on the several immediately succeeding rays when the fin is spread and is often much longer than one-tenth the length of the depressed fin; upper half of body usually of uniform tone; all fins longer in both sexes and in young; caudal fin more square, length 3.5 to 4.5 into standard length in young and adults; Maritime Provinces to Texas.....31

31. (30) Range: Maritime Provinces to northeastern Fla.; total mandibular pores 8; longest anal ray into head length 1.2–1.9 (mean 1.5–1.6); head length into standard length 2.9–3.7 (mean 3.2–3.4); base of dorsal into head length 1.7–2.4 (mean 1.95–2.2); (above proportions taken from 13 specimens from North Carolina, 42–75 mm standard length, mean 59.4, and 25 specimens from New York, 48–98 mm standard length, mean 68.1.....*F. heteroclitus*

Range: peninsular Florida to Mexico; total mandibular pores 10; longest anal ray into head length 1.9–2.6 (mean 2.1); head length into standard length 2.8–3.3 (mean 3.0); base of dorsal into head length 2.1–3.1 (mean 2.6); (above proportions taken from 35 Florida specimens 34–105 mm standard length, mean 53.8).....*F. grandis*

32. (18, 25, 30) Sides of females with numerous dark spots as large as pupil of eye, sometimes confluent into longitudinal lines, vertical bars absent; dorsal rays usually 10 (9–11); along coast from Alabama to southern Texas (Corpus Christi).....*F. pulvereus*

Sides of females with numerous dark, narrow, vertical bars; spots as above absent; dorsal rays usually 11 (10–12); along coast from Chesapeake Bay to Alabama *F. confluentus*

LIST OF SPECIES AND SUBSPECIES

Subgenus **Fundulus** Lacépède

Fundulus heteroclitus heteroclitus (Linnaeus)

MUMMICHOG

Until the variation in *Fundulus heteroclitus* has been adequately described, it seems best not to recognize the northern part of the species as being subspecifically distinct. The characters involved appear to be clinal and do not afford a clear separation. A detailed study of the variation in this species, *Fundulus grandis*, and the populations on Bermuda is needed.

Range: From Anticosti Island in the Gulf of St. Lawrence (Kendall, 1909: 221, 242) south along the Atlantic Coast to the Matanzas River, St. Johns County, northeastern Florida (Miller, 1955: 78). Primarily in brackish water.

Fundulus grandis grandis (Baird and Girard)

GULF KILLIFISH

Range: From the Matanzas River, St. Johns County, northeastern Florida, south along the Atlantic Coast to the Florida Keys, and north and west from there along the Gulf coast at least to Laguna de Tamiahua, Mexico (Miller, 1955: 8). Typically in brackish water.

Fundulus majalis (Walbaum)

STRIPED KILLIFISH

Range: From New Hampshire (Jackson, 1953: 192) along the Atlantic coast to the Matanzas River, St. Johns County, northeastern Florida (Miller, 1955: 9). Typically in salt or brackish water.

Fundulus similis (Baird and Girard)

LONGNOSE KILLIFISH

Range: From the Matanzas River, St. Johns County, northeastern Florida, along the Atlantic coast to Key West and along the Gulf coast at least to a lagoon 35 miles north of Tampico, Mexico (Miller, 1955: 9). Typically in salt to brackish water.

Fundulus confluentus Goode and Bean

MARSH KILLIFISH

Fundulus chaplini Fowler (1940: 8) and *Fundulus bartrami* Fowler (1941: 235–236) are synonyms, respectively, of the male and female of *Fundulus confluentus*. This may be seen by ex-

amination of Fowler's plates and original descriptions and is supported by notes taken by Dr. C. Richard Robins on the type specimens at the Academy of Natural Sciences of Philadelphia. Miller (1955: 2, 4–5) concurs and elaborates on these allocations.

Range: From Chesapeake Bay, Md., along the Atlantic coast to Key West, Fla. (Miller, 1955: 8), and along the Gulf coast to Big Lake, Gulf Shores, Baldwin County, Ala., a few miles west of the mouth of Pensacola Bay (Bailey, Winn, and Smith, 1954: 132). Typically in brackish water.

Fundulus pulvereus (Evermann)

BAYOU KILLIFISH

From the original description *Zygonectes funduloides* Evermann (1892: 85) appears to be the male of *Fundulus pulvereus*, which Evermann described from females in the same paper. It bears little resemblance to *Fundulus grandis* despite Jordan and Evermann's (1898: 2828) suggestion.

Range: From Bayou Minette at Old Spanish Fort, Baldwin County, Ala., a few miles west of the limit of the known range of *Fundulus confluentus* (Bailey, Winn, and Smith, 1954: 132), west along the Gulf coast at least to Corpus Christi, Tex. (Evermann, 1892: 85). Typically in brackish water.

Subgenus **Fontinus** Jordan and Evermann

Fundulus diaphanus diaphanus (Le Sueur)

BANDED KILLIFISH

The variation in this species has been summarized by Shapiro in Hubbs and Lagler (1947: 77). Hybrids between this subspecies and *Fundulus heteroclitus* occur rarely (Hubbs, Walker, and Johnson, 1943: 3).

Range: From Waverly Mills, S. C. (Hubbs and Raney, 1946: 14) "north to the Maritime Provinces; west through the eastern parts of Pennsylvania and New York including the Lake Champlain basin; locally in the Allegheny River System of Pennsylvania (doubtless through introduction)" (Hubbs and Lagler, 1974: 78). Typically in fresh water but occasionally in brackish water.

Fundulus diaphanus menona Jordan and Copeland

BANDED KILLIFISH

Range: "From the eastern parts of the Dakotas through Minnesota, Wisconsin and Michigan and through the northern parts of Illinois, Indiana, and Ohio to southern Ontario and westernmost New York. Intergrading with *F. d. diaphanus* in the Lake Ontario and St. Lawrence basins (as determined by Sydney Shapiro)" (Hubbs and Lagler, 1974: 78). Found in fresh water.

Fundulus waccamensis Hubbs and Raney

WACCAMAW KILLIFISH

This species is closely related to *Fundulus d. diaphanus*.

Range: Known only from Lake Waccamaw, N. C. (Hubbs and Raney, 1946: 14; Frey, 1951: 22). Fresh water.

Fundulus seminolis (Girard)

SEMINOLE KILLIFISH

Range: Peninsular Florida in Lake, Sumter, Okeechobee, DeSoto, Osceola, Charlotte, Polk, and Lee Counties (various Cornell collections) and Wakulla County (University of Florida Collection no. 103). Fresh and brackish water.

Subgenus **Xenisma** Jordan

Fundulus catenatus (Storer)

NORTHERN STUDFISH

Range: Headwaters of the Tennessee and Cumberland Rivers, and the Green River, in Kentucky, Tennessee, Virginia, and Alabama; in clear streams of the Ozarks in Kansas, Arkansas, and Missouri; in tributaries of the Red River in southwestern Arkansas; in the Homochitto River, Miss.; and in the upper part of the East Fork of White River, Ind.; in moderate to swift, clear streams (Miller, 1955: 9).

Fundulus stellifer (Jordan)

SOUTHERN STUDFISH

This species is closely related to *Fundulus catenatus*.

Range: Known only from the Alabama River System in Georgia and Alabama. Cornell material is from tributaries of the Etowah and Oostanaula Rivers of Georgia and the Talladega River in Alabama. Habitat similar to that of *F. catenatus*.

Fundulus albolineatus Gilbert

WHITELINE TOPMINNOW

Range: Known only from clear, cold springs and spring-fed creeks in the lower Tennessee River System of Alabama and Tennessee (Miller, 1955: 9). Hubbs's (1926: 11) mention of *albo-*

lineatus from the "Alabama basin" gives no details and is probably an error.

Fundulus rathbuni Jordan and Meek

SPECKLED KILLIFISH

The intraspecific variation, subgeneric affiliations, and synonymy of this species have been treated by Brown (1955).

Range: Streams of the Piedmont region of North Carolina in the Roanoke, Cape Fear, Neuse, and Pee Dee River systems (Brown, 1955: 212).

Subgenus **Plancterus** Garman

Fundulus zebrinus Jordan and Gilbert

SOUTHWESTERN PLAINS KILLIFISH

Range: Shallow, open streams in the upper portions of the Brazos, Colorado, and Pecos drainages of Texas and New Mexico, and from saline waters on the Llano Estaçado of northwestern Texas (Miller, 1955: 10–11).

Fundulus kansae Garman

CENTRAL PLAINS KILLIFISH

This species has hybridized with *Fundulus sciadicus* (Hubbs, Walker, and Johnson, 1943: 15).

Range: In shallow streams of the Great Plains from Wyoming (Simon, 1946: 96) and South Dakota (where possibly introduced) south to the Red River in northern Texas and the Arkansas River in New Mexico, east to Missouri (Miller, 1955: 11–12).

Subgenus **Zygonectes** Agassiz

Section A

Fundulus luciae (Baird)

SPOTFIN KILLIFISH

Range: Salt marshes from Long Island and New Jersey, where rare (Nichols and Breder, 1927: 55; Greeley, 1939: 84), south to North Carolina (Hildebrand, 1941: 255).

Fundulus jenkinsi (Evermann)

SALTMARSH TOPMINNOW

Range: Salt marshes from Galveston Bay, Tex., to the mouth of the Escambia River, Fla. (Bailey, Winn, and Smith, 1954: 133).

Fundulus cingulatus Valenciennes

BANDED TOPMINNOW

Fundulus cingulatus superficially resembles *Fundulus chrysotus* and *Fundulus luciae*, with which it has been confused in the literature. For a description of the variation in the characters distinguishing *cingulatus* from *chrysotus* see Brown (1956).

Range: In lowland, fresh-water swamps from the region of Okefinokee Swamp in southwestern Georgia south in Florida to the Tamiami Canal and Fort Myers (Brown, 1956), and west to the Escambia River, Ala. (Bailey, Winn, and Smith, 1954: 132).

Fundulus chrysotus (Günther)

GOLDEN TOPMINNOW

Range: In lowland, freshwater swamps from South Carolina to the Tamimai Canal in southern Florida (Brown, 1956), west along the Gulf coast to eastern Texas, and north to southern Missouri and Tennessee (no records from Oklahoma) (Miller, 1955: 10).

Fundulus sciadicus Cope

PLAINS TOPMINNOW

Range: Streams of the Great Plains in the Missouri, Platte, and Arkansas River systems from South Dakota (Churchill and Over, 1938: 62–63), eastern Wyoming (Simon, 1946: 96), and eastern Colorado (Beckman, 1952: 73), east and south to Iowa (Harlan and Speaker, 1951: 137), Missouri (Meek, 1891: 122), and Oklahoma (Hubbs and Ortenburger, 1929: 98).

Section B

Fundulus notti notti (Agassiz)

STARHEAD TOPMINNOW

For a discussion of the variation in *Fundulus notti* see Brown (in press). Range: Gulf coast river systems from the New River of western Florida to Louisiana and eastern Texas (where subspecies uncertain) (Brown, in press).

Fundulus notti dispar (Agassiz)

STARHEAD TOPMINNOW

The range of this subspecies where it meets that of *F. n. notti* remains to be adequately determined.

Range: Lowlands from Iowa, southern Wisconsin, and the Lake Michigan drainage of Michigan and Indiana south to northeastern Arkansas and western Tennessee (Hubbs and Lagler, 1947: 78).

Fundulus notti lineolatus (Agassiz)

STARHEAD TOPMINNOW

Range: Bottomlands from Isle of Wight and Nansemond Counties (Cornell specimens) in southeastern Virginia south along the Atlantic Coastal Plain to central peninsular Florida and west along the Gulf Coastal Plain to the Ochlockonee River of Georgia and western Florida (Brown, in press).

Fundulus notatus (Rafinesque)

BLACKSTRIPE TOPMINNOW

For details on variation and distinguishing characters of this species and *Fundulus olivaceus* see Brown (1956).

Range: In streams and lakes from Mitchell and Grundy Counties of northeastern Iowa, southeastern Wisconsin (both sides of the divide), southern Michigan, and the prairie regions of western and central Ohio south to Kentucky, the Duck River of Tennessee, the Gulf drainages from the Tombigbee River System of Alabama to the Guadalupe River System of Texas, and west to Kay, Creek, and Johnston Counties of eastern Oklahoma, and Kansas (Brown, 1956: 132).

Fundulus olivaceus (Agassiz)

BLACKSPOTTED TOPMINNOW

In view of the following statement about the type of *Fundulus balboae* Fowler by Hubbs (1931: 6) I feel that this nominal species should be allocated to the synonymy of *Fundulus olivaceus* rather than that of *Fundulus notatus*. "Traces are evident of the black spots on the dorsal fin and upper part of the body, which are conspicuous in many southern specimens of *F. notatus*." In 1931 when Hubbs wrote the above, it was thought that the characters mentioned, which are now recognized as those of *F. olivaceus*, were merely color variations of *F. notatus*.

Range: In streams and lakes from the Chattahoochee River System of Alabama and Florida and the Clinch River System of Tennessee west to Texas and the Arkansas and Red River systems of eastern Oklahoma, and north to Morgan County, Missouri, western Kentucky and Tennessee, and the Mississippi and Ohio drainages of Illinois (Brown, 1956: 127–128; Miller, 1955: 10).

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NEWS OF MEMBERS

WALLACE R. BRODE has been elected president-elect of the American Association for the Advancement of Science. WILLIAM W. RUBEY and ALAN T. WATERMAN are new members of the AAAS board of directors. Other officers and committee members include C. B. WATTS, E. RAYMOND HALL, J. HOWARD MCMILLEN, KARL S. QUISENBERRY, A. NELSON SAYRE, J. FRANKLIN YEAGER, and WARD PIGMAN.

LEO A. WALL, National Bureau of Standards, was one of five young Government scientists honored as 1956 winners of the Arthur S. Flemming Award.

WILLIAM D. APPEL, National Bureau of Standards, has been honored by the American Society for Testing Materials for outstanding achievement in research on fibers. He was awarded the Harold De Witt Smith medal.

FRANCIS O. RICE, head of the chemistry department of the Catholic University, has been given the 1957 Hillebrand Award of the Washington section of the American Chemical Society. The award is in recognition of his pioneer work in the field of free radical research.

LEWIS M. BRANSCOMB, National Bureau of Standards, has been awarded a Rockefeller Public Service Award to study the physics of negative ions and low-energy ionic collisions at University College, London, for a year.

DEANE B. JUDD, National Bureau of Standards, was awarded the Inter-Society Color Council's Godlove Award for outstanding contributions to the knowledge of color in science, art, and industry. The award is symbolized by a prism enclosing a gold diffraction grating.

FRANCIS E. WASHER, National Bureau of Standards, was given the Talbert Abrams Award of the American Society of Photogrammetry, for authorship and scientific developments in photogrammetry.

BENO GUTENBERG, director of the Seismological Laboratory of the California Institute of Technology, has been awarded the Emil Wiechert medal of the German Geophysical Association in appreciation of his accomplishments in seismology and in the investigation of the earth's structure. This is the second award of the medal, founded in 1955, for outstanding accomplishment in geophysics.

The Phi Delta Epsilon Fraternity has presented its annual award of merit to JOSEPH KAPLAN, professor of physics at the University of California, Los Angeles, who is at present serving as coordinator of the American contributions to the International Geophysical Year.

ZOOLOGY.—*Some exotic terrestrial isopods (Isopoda: Oniscoidea) from New York State.*[1]

WILLIAM B. MUCHMORE, University of Rochester. (Communicated by Alan Stone.)

(Received December 17, 1956)

The great majority of the terrestrial isopods found in northeastern United States have undoubtedly been introduced from Europe. Some of the immigrants have been more successful and have become more widely distributed than others and at present are among our commonest sowbugs and pillbugs. In upstate New York, for example, the following European species have been reported and may be present locally in great numbers:

Oniscus asellus Linnaeus
Porcellio scaber Latreille
Porcellio spinicornis Say
Metaponorthus pruinosus (Brandt)
Cylisticus convexus (De Geer)
Tracheoniscus rathkei (Brandt)
Armadillidium vulgare (Latreille)

On the other hand, several species are represented in the local fauna which have been reported from the United States only infrequently. These are:

Trichoniscus pygmaeus Sars
Hyloniscus riparius (C. L. Koch)
Miktoniscus medcofi Van Name
Haplophthalmus danicus Budde-Lund
Platyarthrus hoffmannseggi Brandt
Armadillidium nasatum Budde-Lund

To add to the information concerning the ecology and distribution of these less common forms, the following notes are presented.

Trichoniscus pygmaeus Sars

This species has so far been reported from North America only three times. Lohmander (1927) reported specimens found in New York on lily bulbs imported from Scotland (not from Sweden as stated by Van Name, 1936, and Palmén, 1951), and Van Name (1940) reported the finding of a number of specimens in the Garfield Park Conservatory, Chicago, Ill. Recently Palmén (1951) has found a few specimens in two locations in Newfoundland. These two latter finds were both from gardens and represent the first outdoor records for this species from North America. On the basis of these finds, Palmén predicted that *T. pygmaeus* would turn out to occur in further localities on this continent. This prediction has been borne out by the following New York collections:

Rochester, Monroe County, near the Mount Hope Cemetery; numerous specimens found on several occasions along railroad tracks, with *Hyloniscus riparius* and *Haplophthalmus danicus*.

Rochester, Monroe County, Durand-Eastman Park, May 22, 1955; 11 ♂♂ and 8 ♀♀ in debris between large rocks at edge of Lake Ontario, with *Trichoniscus demivirgo*, *Armadillidium nasatum*, and *Tracheoniscus rathkei*.

Bridgewater, Oneida County, June 19, 1955; 2 ♂♂ and 1 ♀ under rocks and trash on bank of small stream at side of highway, with *Trichoniscus demivirgo*.

Rensselaerville, Albany County; many specimens found on several occasions under rocks in ruins of an old felt mill on the E. N. Huyck Preserve, with *Trichoniscus demivirgo* and *Cylisticus convexus*.

It is certain that *T. pygmaeus* is an importation from Europe where it is widespread and synanthropic. It has in all probability been introduced into this country on numerous occasions and has obviously become established in a number of localities. The possibility that the populations discovered in New York represent very recent introductions is remote, since, with the possible exception of the Bridgewater locality, no recent dumping of vegetable wastes or soil has occurred at these stations. The Rensselaerville population, in particular, seems to be a very old one, since it is established around the foundations of an old felt mill which was abandoned in 1879 and fell into ruins before 1895. Many other old isolated populations such as these are undoubtedly scattered around the countryside, at least in the eastern United States. That they have not yet been discovered is certainly due to the very small size of the animal (<2.5 mm) and to its secretive habits, as well as to the scarcity of interested observers.

[1] Part of this work was done during tenure of a Summer Research Fellowship at the Edmund Niles Huyck Preserve, Rensselaerville, N. Y.

Hyloniscus riparius (C. L. Koch)

There is only one previous report of this widespread Central European form from North America. Palmén (1951) found several specimens in two locations in St. John's, Newfoundland—in a garden and in a greenhouse. From these finds he concluded that the species is probably not able to survive outdoors, but is completely dependent on man in Newfoundland.

In Rochester an apparently permanent outdoor population has been located near the Mount Hope Cemetery. Numerous specimens have been found under logs, rocks and debris over a distance of more than half a mile along a railroad embankment and on the cemetery grounds. Both sexes and all stages of the life history are represented. Active animals have been found on various occasions during the ice-free portion of the year, and their hardiness is attested to by the fact that they have just survived the most rigorous winter in Rochester for many years, the average temperature for December having been 24.4° F. and that for January 23.1° F. These points, together with the fact that the main body of the population along the railroad tracks has been separated from the cemetery (the probable point of origin) by a busy 4-lane highway for at least 25 years, indicate that this species is perfectly able to survive and thrive in such a climate as that of Rochester. In this connection it is interesting to note that in this same location where *H. riparius* is found, the exotic chilopod *Chaetechelyne vesuviana* (Newport) also occurs (cf. Crabill, 1955). These two species of organisms, which have somewhat similar ranges in Europe, apparently have similar ecological requirements and have been almost equally successful in establishing themselves in this foreign niche.[2]

It is very interesting to note that in the area along the railroad tracks *H. riparius* almost completely replaces the indigenous trichoniscid isopod, *Trichoniscus demivirgo* Blake. The latter species is common under rocks and logs in damp places throughout the Rochester region, and indeed, is abundant at the periphery of the area occupied by *H. riparius*. Within this area, however, very few *T. demivirgo* can be found, although, as mentioned above, the other trichoniscids *T. pygmaeus* and *H. danicus* occur in numbers along with *H. riparius*. It appears that *H. riparius* and *T. demivirgo* have very similar ecological requirements and that the former is more successful in its occupation of a favorable habitat than the latter, with the result that *T. demivirgo* is excluded almost completely.

Miktoniscus medcofi Van Name

In the greenhouse of the University of Rochester are several small, but thriving, colonies of a small isopod which has been identified provisionally as *Miktoniscus medcofi*. This species was described by Van Name (1940) from specimens found in the greenhouse of the University of Illinois, Urbana, Ill. At the same time Van Name reported specimens from another greenhouse in Urbana, and from the Garfield Park Conservatory, Chicago. The only other record of this species is the recent report by de Castro (1953) of specimens from three outdoor locations in Rio de Janeiro, Brazil. On the basis of these finds, de Castro suggests that Brazil may be the native habitat of the species.

Although he was confident in the identification of his specimens as *M. medcofi*, de Castro recognized certain peculiarities of his specimens and presented an extensive redescription of the species. In particular, he pointed out differences in the second pleopod, namely, the exopodite is larger in its terminal portion and the endopodite is proportionally much shorter than the corresponding structures as figured by Van Name (1940, p. 111). Furthermore, it should be noted that the Brazilian specimens are without pigment, while the United States specimens are described as "strongly pigmented, having the upper surface handsomely variegated with brown or purplish-brown pigment on a light background . . ." (p. 112). And the distal segment of the endopodite of pleopod I of the male is distinctly shorter than the proximal segment in Brazilian, but subequal in the United States specimens. Also, the basal segment of the uropod is apparently much narrower in Brazilian, than in United States specimens.

The specimens found at Rochester generally resemble those described by Van Name and de Castro but seem to differ from one or both forms in certain respects, namely, in the shape and proportions of the endopodite of pleopod II of

[2] Since preparation of this manuscript, a population of *Hyloniscus riparius* has been discovered in a small trash dump along U. S. Highway 20, 2.6 miles east of Lafayette, Onondaga County, N. Y.

the male; in the shape of the ischium, merus and carpus of pereiopod VII of the male; and in details of the antennae, pleopods III–V and uropods. In addition, it should be noted that these specimens are similar in many respects to specimens which have been described as *M. linearis* (Patience, 1908; Kesselyak, 1930; Vandel, 1950) and *M. humus* (Mulaik, 1942), though again certain differences are evident. Furthermore, Eberly (1954) has noted the finding in Cascades Park, Bloomington, Indiana, of a single specimen probably belonging to the genus *Miktoniscus*, but having "some differences from any of the species of *Miktoniscus* described from America." It seems certain that two or more species are represented by these several lots of specimens but, because of inaccuracies and inadequacies of the published descriptions, it is impossible at present to decide exactly what species are involved. As Vandel points out, it will not be possible to determine the identity or non-identity of the forms until a direct comparison of types can be made. Until such time as a positive identification can be made, it seems best to consider the Rochester specimens as belonging to *M. medcofi*, which they most closely resemble.

Haplophthalmus danicus Budde-Lund

This is another common European form which has been widely spread by man's activities. It has become established in a number of places in this country, living both indoors and out. It has been recorded outdoors from Indiana, Maryland, New Jersey, Pennsylvania, Kentucky, Tennessee, and Utah, and from greenhouses in Toronto, Ontario. Palmén (1951) has reported outdoor finds in southern Newfoundland and concludes from the circumstances that the species may be able to survive there. Eberly (1954) has found this species widely distributed in Indiana, frequenting "moist soil under boards and logs."

In New York I have found the species well established in the greenhouses of the University of Rochester, and in four outdoor locations as follows:

Rochester, Monroe County, near the Mount Hope Cemetery; number of specimens on several occasions, under logs along railroad tracks; with *Trichoniscus pygmaeus* and *Hyloniscus riparius*.

Powder Mill Park, Monroe County, April 1955; numerous individuals in two locations at least a mile apart; under logs on wet ground.

Rensselaerville, Albany County; large population in old trash on creek bank in the village; with *Trichoniscus demivirgo, Tracheoniscus rathkei*, and *Oniscus asellus*.

There is no doubt that these outdoor populations are permanent. Judging from the numbers of individuals found and from the surroundings, they cannot have been introduced recently. On the basis of these records, it appears that *H. danicus* can withstand rather rigorous winters, and in all probability will be found to be more widespread than supposed, even in the northern portion of the country and in southern Canada. As Eberly suggests, these small animals are probably "often overlooked because of their size, by people who think they might be just the young ones of other common species with which they are found."

Platyarthrus hoffmannseggi Brandt

This species also is widespread through Europe, being commonly found in the nests of ants, with which it apparently enjoys some sort of symbiotic relation. It has been reported in North America only from the vicinity of New Haven, Conn. (see Van Name, 1940, and Brooks, 1942).

In Rochester, a colony of *P. hoffmannseggi* has been found along the railroad tracks near the Mount Hope Cemetery, in the same area occupied by *Hyloniscus riparius* and other exotic forms. The colony is established in an ants' nest under an old railroad tie lying on the roadbed of stones and cinders. The nest is occupied by the ant, *Formica sanguinea subnuda* Emery and its slave *Formica fusca* Linnaeus.[3] On June 8 and June 27, 1956, brief collection by hand and Berlese separation of some of the material from under the tie yielded 69 specimens (25 males and 44 females), together with specimens of the other isopods *Haplophthalmus danicus, Hyloniscus riparius, Trichoniscus demivirgo, Oniscus asellus*, and *Tracheoniscus rathkei*.

Though I find no mention in the literature of such a situation, there seems to be a considerable difference in size between the sexes of *P. hoffmannseggi*. Contrary to the opinion of Brooks (1942, p. 436) that this species is "never more than four millimeters in length", and the statement of Edney (1953, p. 74), "up to 3.6 mm long", the largest female collected here is 5.76

[3] The ants were determined by Dr. Marion R. Smith at the United States National Museum.

mm long, and the average length of 33 mature females is 4.32 mm. On the other hand, the largest male collected is only 3.40 mm long, the average length of 23 males being 2.61 mm. It may be, of course, that all the males collected are immature animals, therefore are smaller than the females. But if this is so, then it must be assumed that mature males were not, at the time of collection, present in the colony, or else that the mature males were deep in the nest and escaped capture. Either of these situations should provide the basis for an interesting study.

The large size of female specimens and the size differential between males and females might suggest that we are dealing here with a species of *Platyarthrus* distinct from *hoffmannseggi* or with a subspecies of *P. hoffmannseggi*. No significant morphological differences have been detected, however, on comparing our specimens with the descriptions given by Meinertz (1934), Verhoeff (1936), and Edney (1953). Until direct comparison with European material should prove otherwise, it can only be concluded that our specimens are minor variants of *P. hoffmannseggi*.

Armadillidium nasatum Budde-Lund

This species has been widely reported through the U. S. and in southern Canada but its occurrence has for the greater part been confined to greenhouses and warmed buildings (cf. Van Name, 1936, and Hatchett, 1947). Only one report (Van Name, 1940) specifically mentions the finding of specimens (two) outdoors "under pieces of wood at Glenview, Illinois, northwest of Chicago, Oct. 3, 1936." There is no indication how close the point of capture was to human habitations or hothouses. Eberly (1954) notes that *A. nasatum* has been found in Brown and Monroe Counties, Ind., but he neglects to mention the habitats of the animals collected. It may be presumed, however, they do exist outdoors in these southern Indiana localities.

In Rochester, *A. nasatum* is very common in greenhouses at the University of Rochester and in Highland Park. In addition specimens have been found outdoors in four separate locations. Immediately around the university greenhouse, *A. nasatum* is very common through the summer months, along with *A. vulgare* and *Cylisticus convexus*. This population is without doubt one which winters in the building foundations and expands outside, with the coming of warm weather. Further finds have been made, however, at stations some distance removed from any warmed building: under old wooden ties on a railroad embankment at Genesee Valley Park (2 ♂♂ on April 29, 1955; 3 ♂♂ on May 20, 1956); in a similar situation at the shore of Lake Ontario in Durand-Eastman Park (4 ♂♂ and 1 ♀ on May 22, 1955); and under a board in a trash dump of the Mount Hope Cemetery (1 ♀ on May 29, 1955). The latter specimen, while found outdoors, might have been carried to this place only shortly before collection on greenhouse flowers brought to the cemetery. The first two mentioned finds, however, seem certainly to be from permanently established populations, since in each case the station is not near a building and no reasonable mode of recent introduction can be conceived. It is probable that the animals are able to overwinter in these locations by burrowing deeply into the loose material of the railroad bed.

The population of *A. nasatum* living outside the greenhouse at the University of Rochester is actually a very hardy lot. Although they undoubtedly burrow deeply along the building foundations during the very cold weather, they apparently can tolerate temperatures near freezing, for immediately after the snow melted and the ground thawed from our past winter (March 30, air temperature about 35° F.) specimens were found active under a 1-foot-square piece of insulating board lying on the ground 2 feet from the building. Also present were individuals of *Cylisticus convexus* and *Tracheoniscus rathkei*. A few days later, after a 5½-inch snowfall, the snow was brushed away and a few specimens were found under the board, lethargic but still alive. This observation is noteworthy in view of the fact that Hatchett (1947) never found *A. nasatum* outside the greenhouse in Ann Arbor, Mich., even though inside it was as abundant as *A. vulgare*, which in turn was common outside as well as in.

DISCUSSION

The outdoor occurrence in upstate New York of *Hyloniscus riparius*, *Haplophthalmus danicus*, *Trichoniscus pygmaeus*, and *Armadillidium nasatum* is most interesting from a biogeographical point of view. These species are found throughout central and western Europe as far north as the North Sea coast. The last three named are also common in

the British Isles, but *H. riparius* apparently has not been introduced across the channel (see Edney, 1953); and *T. pygmaeus* and *H. danicus* have been reported from Norway (Oslo) by Sars (1898). In the cooler regions of Europe, which correspond climatically to upstate New York, these four species have been found only in greenhouses and other artificially warmed situations. Meinertz (1932, 1934) has reported all four in and around greenhouses in Denmark, and Palmén (1946, 1947) has found them in similar situations in Finland. Furthermore, in Newfoundland, which has a similar climate, *H. riparius*, *T. pygmaeus*, and *H. danicus* have been found living outdoors during the summer, but under such circumstances as to raise a doubt whether they are able to survive the winters outside (see Palmén, 1951).

The New York state localities, namely Rochester and Rensselaerville, are similar in climate to Denmark, southern Finland, and Newfoundland, at least in so far as the winters are concerned. In all these places the winters are fairly rigorous and damp, with the January temperature averaging 5 to 10 degrees below freezing, Fahrenheit. Considering climate alone, one would definitely not expect to find these isopods in either Rochester or Rensselaerville. Fortuitous circumstances have, however, made survival possible through the coldest winters experienced by these localities. All of my finds of the isopods under consideration have been made in situations where the substratum is very loose, that is, in railroad beds of rocks and cinders, in dumps of rocks, trash and ashes, and among crumbling building foundations. In such situations, apparently, the animals are well provided with food and moisture during warm weather and in cold weather are able to descend quickly to a depth sufficient to protect them from freezing.

Platyarthrus hoffmannseggi also is widespread in Europe, being found as far north as the British Isles (Edney, 1954) and Denmark (Meinertz, 1934), but apparently absent from Norway (Sars, 1898) and Finland (Palmén, 1946). This species, being myrmecophilous, might be expected to be more resistent to cold weather than many other isopods, since it always has the opportunity to retire easily to the depths of the ants' nest whenever conditions become adverse. On this basis, its occurrence in Rochester is easy to understand, and the possibility that it could withstand even more rigorous climates seems good.

The finding of *P. hoffmannseggi* with *Formica sanguinea subnuda* and *Formica fusca* adds these two forms to the list of ant hosts in this country. It should be noted, however, that in England the isopod has been found living with *F. fusca* and with the typical form of *F. sanguinea* (see Brooks, 1942, p. 428). It seems probable that the isopod was introduced from Europe into Rochester along with *F. fusca* and that subsequently the local ant, *F. sanguinea subnuda*, moved in to enslave *F. fusca* and to share the nest with its other occupants.

The geographical distribution of the several species in the genus *Miktoniscus* has been discussed by Vandel (1949, 1950), who points out that *Miktoniscus* is a typical North Atlantic genus. The recent suggestion of de Castro (1953) that *M. medcofi* originated in the southern hemisphere may or may not be valid. Two of the three finds of *M. medcofi* mentioned by de Castro were made in areas modified by human habitation, that is, in a banana grove and on a country estate. (Habitat data for the third find is not given.) It is entirely possible that the species has been introduced into the Rio de Janeiro region from some North American or European locality and that it has become locally established there, where it should have no difficulty in living outdoors. Only further, more intensive, collection can cast more light on this problem.

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WIND RIVER FOSSILS

Finding of a "missing link" in the evolution of modern mammals—a creature that had branched off from the great family of odd-toed ungulates, which includes the horse and rhino, toward the present tapir—is reported by C. Lewis Gazin, Smithsonian Institution curator of vertebrate paleontology.

This ancient animal, of which a fossil jaw and parts of a skull were found in the Wind River basin of Wyoming, was *Dilophodon,* about the size of a fox, which lived during the upper Eocene period of geological time, about 45,000,000 years ago. The Wind River area long has been a favorite hunting ground for mammals of the Eocene, the period when the warm-blooded creatures began to take on some of their present forms.

Also encountered were the fossil remains of a somewhat larger tapiroid, *Desmatotherium,* rather resembling the smaller tapir, *Dilophodon,* but cannot be considered directly ancestral to any living form although representative of the general complex from which arose rhinos, horses, tapirs, and certain groups of extinct hoofed mammals.

The points at which the divergence to the modern forms took place are of considerable significance to paleontologists. The Wind River area, Dr. Gazin says, is especially rich in tapiroid material and living in the same area, at roughly the same time, were ancestral opossums, rabbits, rodents, and carnivores.

ZOOLOGY.—*The systematics, affinities, and hosts of the one-tentacled, commensal hydroid* Monobrachium, *with new distributional records.* CADET HAND, University of California. (Communicated by F. M. Bayer.)

(Received December 21, 1956)

The hydroid *Monobrachium parasitum* was first described by Mereschkowsky (1877) from the White Sea. Subsequently Leche (1878) reported it from Nova Zembla in the Kara Sea, Wagner (1890) from the Bay of Solowetzk near the isles of Baby-Loudy and Nowny-Loudy in the White Sea, Levinsen (1893) from Umanak, Egedesminde, and Frederikshaab along the west coast of Greenland, and Bønnevie (1899) from near Spitsbergen. All these localities are within the boundaries of the Arctic Ocean. It was not until Stafford (1912) discovered *Monobrachium* in the Gaspé region of Canada that its distribution was extended to the Atlantic and to lower latitudes. Fraser (1918) further extended the known range of this species when he described it from Nanoose Bay, British Columbia, on the Pacific coast of Canada. Fraser's report is the last new record of *Monobrachium* to the present date, and the known distribution would include the Arctic, Atlantic, and Pacific stations reported above. In view of the presumed circumboreal distribution of *Monobrachium*, and the fact that it has never been reported south of lat. 48° N. in either the Atlantic or Pacific, it was with some surprise that I discovered *Monobrachium parasitum* to be abundant in relatively shallow water off the west coast of California and Baja California in the area from about lat. 34° to 32° N.

Mereschkowsky gives no precise Latin or Greek stem for the specific name *parasitum* which he choose for this species, and it is interesting that certain authors [Leche (1878), Wagner (1890), Bonnevie (1899)] have used the name *parasiticum* for this animal. If we assume that Mereschowsky derived his specific name from the Latin noun for "a parasite" it would appear that he has treated this noun as an adjective and caused it to agree grammatically with the generic name, a procedure at variance with the modern Rules, which state that nouns must be appositional, nominative, or possessive genitive. It may have been because of the agreement of the genders of the two names that the authors cited above chose to use the adjectival specific name *parasiticum*. No matter what Mereschkowsky's intention in this matter was, there seems to be no way in which we can change the orthography of the name at this date. We must accept Mereschkowsky's name as an abbreviated adjectival stem which he chose in preference to the full stem of the original Latin adjective. Therefore, I shall use Mereschkowsky's name *M. parasitum* for this species.

This hydroid has been reported only as living upon the shells of bivalves and always near the posterior end of the shells or surrounding the siphons. Mereschkowsky found it upon *Tellina solidula*, although Leche (1878) had specimens of both *T. solidula* and *T. lata* but found it only on *T. lata*. Leche comments that Mereschkowsky's drawing of *T. solidula* looks more like *T. lata* than *T. solidula*. Wagner (1890) describes the mollusk host only as a *Tellina*, but he cites in his introduction the occurrence of *Monobrachium* on *Tellina calcarea*. In a footnote to that citation he refers to the work of Leche (1878) who does not mention *T. calcarea*. Perhaps *Tellina calcarea* of Leche is *Macoma calcarea*. Levinsen (1893) found *Monobrachium* on *Macoma calcarea* and *Tellina moesta*, while Bonnevie (1899) does not identify the host clam. The Atlantic examples of *Monobrachium* found by Stafford (1912) occurred on *Tellina tenera* and the Pacific material of Fraser (1918) on *Axinopsis sericatus*. Most of the above bivalves are small species, seldom exceeding 4 cm in greatest dimension, while others such as *Axinopsis* are minute and are little more than 2 mm in diameter. The material from California occurs on several different species of bivalves. These include a 2 mm long immature *Tellina* sp., *Axinopsis viridis* and *Aligena redondoensis*.

These mollusks were kindly identified for me by Dr. Myra Keen of Stanford University. The latter two species above are minute species and seldom exceed a few millimeters in diameter. One notes here that the Atlantic and Arctic hosts of *Monobrachium* are clams of considerably greater size than those from the Pacific. Also, it seems worthy of mention that with the exception of *Macoma calcarea*, all the clam hosts have very short siphons, or none at all, and live at the surface of the ocean's bottom. This habit of the clam hosts must be a prerequisite for *Monobrachium*, since if these hosts were to burrow much below the surface it seems unlikely that the hydroid could survive. Unfortunately, there are no adequate descriptions of the hydroid as a living animal, although Fraser (1918) notes the similarity of the posturing of *Monobrachium* to that described by Gosse (1857) for *Proboscidactyla* (= *Lar*).

The material upon which the present report is based came into my hands from several sources. The first five specimens were collected by William Walton, of the Scripps Institution of Oceanography, from depths of 40 to 65 fathoms in Todos Santos Bay, Baja California, November 1952 and March and April 1953. Mr. Walton also gave me a sixth specimen which he collected on August 20, 1952, in Todos Santos Bay. This specimen, taken at a depth of 165 fathoms, is unique not only in the great depth at which it was found but also in that it was living upon the test of the arenacious foraminiferan *Haplophragmoides planissimum*. This is the first indication that *Monobrachium* will accept any others than bivalves as a host substrate.

Six specimens of *Monobrachium* were received from Dr. Olga Hartman, of the Allan Hancock Foundation of the University of Southern California. These specimens were taken at 42 fathoms in Santa Monica Bay, Calif.

The remaining material consisted of 72 specimens which were collected in June, October, and November 1953 in depths of from 30 to 120 fathoms by Robert Bieri, of the Scripps Institution of Oceanography. This material was obtained from positions southwest and west of Point Loma, San Diego, Calif., and within approximately one mile of the Point. The bottom varied at these stations from a fine sand to soft, silty deposits.

The hydroid *Monobrachium parasitum* has been well described by its original finder, and Wagner (1890) has given a very complete description of both the hydroid and medusa. Bonnevie (1899) added to Wagner's description and Fraser (1918) redescribed this species. The material I have observed seems to differ in no significant way from what has been described previously and little is to be gained by a redescription. However, certain features of the material I have examined do not agree precisely with what has been previously recorded and these will be mentioned, along with some new observations.

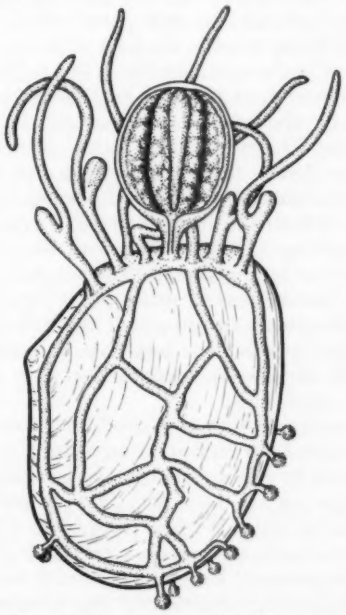

FIG. 1.—A colony of *Monobrachium parasitum* with one adult female medusa.

I have already commented on the fact that the bivalve hosts of the Pacific representatives of *Monobrachium* are smaller than those in the Arctic and Atlantic Oceans. This condition may result merely from an absence in the Pacific fauna of clams of

several centimeters' length of suitable habits and habitats, or could reflect genetic differences in the Pacific hydroid. It is possible that the Pacific *Monobrachium* is another species, but I have little evidence to favor this view. As a result of the smaller hosts, however, the appearance of the colonies which I have observed is slightly different from that of those figured from the Arctic. The accompanying Fig. 1 illustrates a small colony of *Monobrachium* from Santa Monica Bay and shows how the hydrorhizal network wanders over the whole shell surface to the very margin where the curious knobbed defensive zooids stand. If one compares this with the descriptions and figures of Mereschkowsky, Wagner, and Bonnevie one notes that in their material the colony, including all of the hydrorhizal net and defensive zooids, seldom covered more than the posterior one-third of the host shell.

Another minor difference between Pacific and other representatives of *Monobrachium* concerns the size of the polyps. In the material I have examined it has been very seldom that a polyp 1 mm long has been present. Fraser (1918) gave the polyp size as 0.7 to 0.8 mm in height. Arctic polyps are reported up to 2 mm long with the single tentacle as long as 5 mm. However, knowing from observations of other naked hydroids the extreme changes in size of which they are capable, it seems unlikely that the smaller size of the Pacific material has any very great significance.

Some interesting and important observations have been made on the medusae found attached to various colonies. In general, the medusae are not more than 2 mm in greatest dimension and only rarely have I found more than one large medusa on a colony. Perhaps for this reason I have not been able to confirm Bonnevie's observation that medusae of both sexes occur in a single colony. The wide and thick radial canals, the paired gonads along the canals, the nearly solid ring canal and the light covering of perisarc over the medusae all agree with previous descriptions. Also the delicate velum, the very short, closed manubrium and the 16 small hollow tentacles agree with earlier observations. However, between the second and third order of tentacles in each quadrant there occurs a single, external, closed, endodermal statocyst which has been all but overlooked by previous authors (see Fig. 2). It was only Wagner (1890) who seems to have seen these structures at all, and he describes them as masses of cells which he took to be rudiments of marginal sensitive bodies. He goes on to say that such sensitive bodies are wanting in the medusae of *Monobrachium*. I have found in sections of 3 medusae and in several examined under the pressure of a cover slip that the statocysts are readily demonstrable and are clearly closed and endodermal. The three medusae sectioned were to all appearance adult, and the eggs of the two females showed large germinal vesicles and looked as if the eggs were ready to be shed. There is no indication in the material I have examined that these medusae are released, and one attached medusa I observed had shed all but a few of its eggs. This, however, is not positive evidence that the medusae may not be released before spawning, since it is quite possible that the eggs could have been squeezed out of the medusa by other material in the dredge or when the haul was sorted.

Mereschkowsky (1877) figured a nematocyst of *Monobrachium* which is clearly a microbasic eurytele. I have examined both the hydroid and medusoid stage and can find but one type of nematocyst, a microbasic eurytele from 7 to 11μ in diameter by 9 to 16μ in length. There is no difference in size

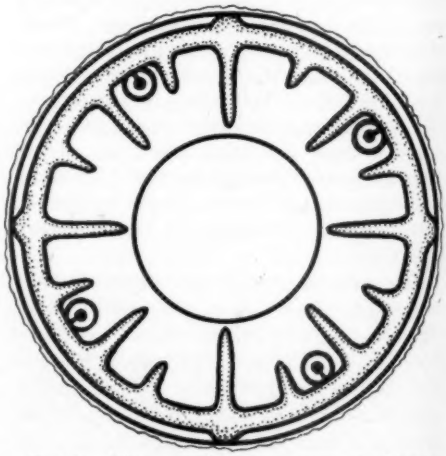

FIG. 2.—Diagram of the arrangement of tentacles and statocysts of an adult medusa of *Monobrachium parasitum*.

ranges between the nematocysts of the hydroid and its medusa.

The systematic position of *Monobrachium* has not to date been clearly established. *Mereschkowsky* (1877) believed it a member of the Athecata and on the basis of its single tentacle he established a new family, *Monobrachiidae*, for it. Mereschkowsky was impressed with the many analogies of his animal to "*Lar*", but felt that the two were quite separate. It seems curious that Mereschkowsky did not give more weight to his own observation that the gonads were developing beneath the radial canals, which should have suggested to him, as it did later to Bonnevie (1899), that *Monobrachium* was a leptomedusan. Levinsen (1893) listed *Monobrachium* in the Laridae (now the Proboscidactylidae) without comment. Bonnevie (1899), after considering the evidence available to her, felt that this hydroid was on the borderline between the thecate and athecate hydroids. Fraser (1918) made a point of the differences in number of radial canals between the genera *Lar* and *Monobrachium*, but commented that if the gonads of *Lar* were placed in a position similar to those of *Monobrachium*, the two genera should be placed in the same family. Fraser seems not to have been aware of the work of Browne (1896), who demonstrated that *Lar* was the hydroid stage of *Proboscidactyla* (= *Willia*) and that the medusae of the two genera in question have very different gonadal patterns. Fraser (1937, 1944) listed *Monobrachium* in its own family, the Monobrachiidae, and he continued this classification in 1946. Hand and Hendrickson (1950) considered *Monobrachium* to be a member of the family Proboscidactylidae.

As mentioned earlier, *Monobrachium* possesses closed endodermal statocysts and has a monocnidom of microbasic euryteles. Also, the endoderm of the tentacles of the hydroid is in direct continuity with that of the gastric cavity, and the tentacles of the medusa are hollow. These characters, taken in their totality, can only be indicative of one group of Hydrozoa, the Limnomedusae. Among the Limnomedusae only a single family, the Olindiidae, has endodermal statocysts; we face the question of whether or not to place *Monobrachium* in this family.

There seems to be no question that both hydroid *Monobrachium* and medusa of *Monobrachium* are highly specialized. The hydroid, as a commensal, presumably "fishes" in the incurrent stream of the bivalve host, and the one tentacle apparently suffices as a food-gathering organ. The hydroid is more reduced than that of *Gonionemus* (= *Haleremita*), but not so reduced as the tentacle-less hydroid of *Craspedacusta* (= *Microhydra*). The medusa of *Monobrachium*, however, would be the most highly specialized of all the Olindiidae. It is presumably never released and its minute tentacles, nearly closed ring and radial canals, and closed mouth all point to its reduced nature. If we compare the development of *Gonionemus murbachi* with what I call the adult *Monobrachium*, we see a close resemblance in the 16 tentacles and 4 statocysts of *Monobrachium* to the young of *Gonionemus* (see Russell, 1953, p. 402). Also, the monocnidom of *Monobrachium* is the same as that of *Craspedacusta* (and *Microhydra*), *Gonionemus* (and *Halermita*) and *Olindias* (see Weill, 1934). From the above facts and considerations I have come to the conclusion that *Monobrachium* should be assigned to the Olindiidae, and there is no reason why we should retain the monotypic Monobrachiidae.

I wish to thank Dr. Erik Zeuthen for translating for me pertinent parts of the papers of Leche and Levinsen and Dr. Ralph I. Smith for reading the manuscript.

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PLANT-GROWTH "BRAKE"

There is a "brake" on plant development—perhaps one of Nature's most fundamental controls over surging life. It is a relatively narrow band of light on the edge of the invisible infrared in the solar spectrum. This phenomenon is reported by Dr. R. B. Withrow, head of the Smithsonian Institution's Division of Radiation and Organisms, where the effects of light on the growth and development of plants and animals is being investigated.

Plant life, and through plants all life, is tied intimately to certain solar wave bands. It has long been recognized that the cornerstone of all life on earth is the process of photosynthesis by which plants, through energy provided by sunlight, are able to synthesize carbohydrates from water and carbon dioxide taken from the air. Animals eat these carbohydrates, the basic food. Other animals eat the carbohydrate eaters, and thus the chain extends from the simplest organisms to man.

But without some other process the carbohydrates might be a formless mass. The second process, long studied by the Smithsonian workers, is that which shapes a plant and controls development of stems, leaves, and blossoms. This, Dr. Withrow points out, may be a light effect second in importance only to photosynthesis itself. It requires very little solar energy. Experiments have demonstrated that the control is exercised by red light with a maximum of efficiency at wavelengths around 660 millimicrons—or millionths of millimeters. The Smithsonian findings have been substantiated in several other laboratories. It has been demonstrated, however, that this formative action can be blocked effectively by irradiation with wavelengths in the far red. The greatest effect is at wavelengths between 710 and 730 millimicrons.

The "brake" is not applied immediately. The maximum efficiency of the far red energy occurs a little more than an hour after the plant is exposed to the formative wavelengths, Dr. William Klein, another Smithsonian scientist, has found. The implication is that the action is an interference with the development process by acting on some product the formation of which is initiated by the shorter red wavelengths. The experiments have been carried out with seedlings of beans.

In other experiments by Dr. Withrow and Dr. C. C. Moh, at the Radiation and Organisms laboratory, it was found that damage to plants from X-ray exposure—insofar as this results in breaking the bundle of genes, or units of heredity—can be increased from 30 to 50 percent by previous exposure to about the same wave band of far red light that reverses the formative process. On the other hand, the increase in damage is nullified if the X-ray exposure is followed by exposure to the red wave band.

Breaking of the chromosomes, or strings of genes, is one of the first evidences of damage to living organisms by exposure to ionizing radiation. This breaking is responsible for some of the adverse hereditary effects concerning which there has been a great deal of publicity, because of possible effects of the atomic bomb fall-out.

The Smithsonian experiments were carried out with pollen of *Tradescantia* flowers and root tips of beans where results are relatively easy to determine. Work is now in process to determine how the red and far red spectra exert their effects, and how the results may be applied to altering effects of ionizing radiation in higher animals and men.

HERPETOLOGY.—*Contributions to the herpetology of Virginia, 3: The herpetofauna of Accomac and Northampton Counties, Va.* CLYDE F. REED, Baltimore, Md. (Communicated by Doris M. Cochran.)

(Received December 6, 1956)

The southernmost area of the Delmarva Peninsula consists of two counties of Virginia, Accomac, the more northern, and Northampton, the more southern. Both are isolated from the mainland of Virginia by the lower Chesapeake Bay.

The herpetofauna as well as the flora indicates that these counties have had some land connections in the past with southeastern Virginia. Many plants in this region range from coastal Florida and Georgia, northward through the Carolinas to southeastern Virginia, and then find their northern limit on the Delmarva Peninsula; these same plants are totally absent west of the Chesapeake Bay in Maryland. Most notable of the plants having the foresaid distribution are: *Baptisia alba*, *Callicarpa americana*, *Smilax bona-vox*, *Zanthoxylum clava-herculis*, *Bignonia capreolata*, *Tillandsia usneoides*, *Trillium pusillum* var. *virginianum*, *Smilax laurifolia*, *Berchemia scandens*, *Vitis rotundifolia*, *Symplocos tinctoria*, and *Passiflora incarnata*. The herptiles having a similar distribution from the south on Delmarva are: *Hyla cinerea* (see Reed, Journ. Washington Acad. Sci. **46**(10): 328–332. 1956), *Scaphiopus holbrooki* (see Reed, Herpetologica **12**(4): 295. 1956), *Eumeces laticeps*, *Sceloporus undulatus hyacinthinus*, *Lygosoma laterale*, *Diadophis punctatus punctatus*, *Lampropeltis getulus getulus*, *Natrix erythrogaster* (see Conant, Herpetologica **2**(5): 83–86. 1943), *Pseudemys rubriventris* and *Malaclemys terrapin*.

On the other hand, Delmarva-Virginia is terrestrially attached firmly to the larger land mass to the north, which in turn is continuous with the Piedmont Region of Maryland, Delaware and Pennsylvania. As a result of this land continuity, many Piedmont species of plants and animals have taken up residence on the Delmarva Peninsula; both have migrated the whole length of the peninsula, but it is interesting to note that both have become localized together. About 150 species of Piedmont species of plants are known from various areas on the peninsula; these have been discussed in detail in a botanical paper, The Piedmont Flora of the Delmarva Peninsula, by the author. The herpetofauna of the Delmarva Peninsula has been annotated in detail in Contribution 13 to the Herpetology of Maryland and Delmarva, published by the author. Most notable of the Piedmont herpetofauna found in Accomac and Northampton Counties, Virginia are: *Bufo terrestris americana*, *Diemictylus viridescens viridescens*, *Eurycea bislineata bislineata*, and *Haldea valeriae*. Other Piedmont herptiles found on Coastal Delmarva in other Piedmont areas are: *Hemidactylium scutatum*, *Clemmys insculpta*, *Natrix septemvittata*, *Desmognathus fuscus fuscus*, *Pseudotriton ruber ruber*, *Rana sylvatica sylvatica*, *Storeria dekayi dekayi*, *Storeria o. occipitomaculata*. Many of these Piedmont herptiles have also been collected in Southern Maryland and on Northern Neck, Virginia (see Reed, Journ. Washington Acad. Sci. **47**(1). 1957).

There are 38 species of herptiles definitely known from Accomac and Northampton Counties, Virginia. Four of these species are Piedmont in distribution otherwise and are quite removed from the nearest next area of distribution. Many of the species show definite affiliations with species of more southern distributions.

In addition to the papers mentioned above, the following articles provide published records of herptiles from Accomac and Northampton Counties. In the following annotated check list of the herptiles for these two counties of Virginia, these publications will be referred to by date only. Dunn, E. R. (A preliminary list of the reptiles and amphibians of Virginia), Copeia 1918, no. 53: 16–27. Brady, M. K. (Notes on the Herpetology of Hog Island (Va.)), Copeia 1925, no. 136: 110–111. Fowler, H. W.

(Records of amphibians and reptiles from Virginia), Copeia 1925, no. 146: 65–67. Conant, Roger (An annotated check list of the amphibians and reptiles of the Del-Mar-Va Peninsula), Publ. Soc. Nat. Hist. Delaware, pp. 1–8. 1945.

The specimens in the United States National Museum have been seen and records for those specimens are cited below. I wish to thank Dr. Doris M. Cochran for allowing me to study these specimens. New or additional records have been obtained by the author in his many trips to this region in the past five years. These are also cited below along with citations of the records previously published by other responsible herpetologists.

1. *Scaphiopus holbrooki holbrooki* (Harlan): Spadefoot toad. ACCOMAC COUNTY: Conant, 1945; Reed, Herpetologica **12**(4): 295. 1956.

2. *Bufo woodhousei fowleri* Hinckley: Fowler's toad. ACCOMAC COUNTY: Chincoteague, Fowler, 1925; Wachaprague. July 9, 1956, *Reed* 1143–48; Chincoteague Island (U.S.N.M. 61733–41). NORTHAMPTON COUNTY: north of Cape Charles, Oct. 22, 1955, *Reed* 1059; Smith Island (U.S.N.M. 40227–41); ACCOMAC AND NORTHAMPTON COUNTIES: Dunn, 1918; Conant, 1945.

3. *Bufo terrestris americanus* Holbrook: American toad. ACCOMAC COUNTY: Conant, 1945, northern part of county. NORTHAMPTON COUNTY: Hog Island, Brady, 1925.

4. *Acris gryllus gryllus* (LeConte) and *A. g. crepitans* Baird: Cricket frogs. ACCOMAC COUNTY: Dunn, 1918; Locustville, Fowler, 1945; Conant, 1945. NORTHAMPTON COUNTY: Conant, 1945.

5. *Hyla cinerea* (Schneider): Green tree frog. ACCOMAC COUNTY: 2 miles south of Oak Hall, July 9, 1956, *Reed* 1107. See Reed, Jour. Washington Acad. Sci. **46**(10): 328–332. 1956. NORTHAMPTON COUNTY: Conant, 1945.

6. *Hyla crucifer crucifer* Wied: Spring peeper. ACCOMAC AND NORTHAMPTON COUNTIES: Conant, 1945.

7. *Hyla versicolor versicolor* LeConte: Common tree frog. ACCOMAC COUNTY: Wachaprague, July 9, 1956, *Reed* 1136–1142; 2 miles south of Oak Hall, July 9, 1956, *Reed* 1108. NORTHAMPTON COUNTY: Conant, 1945.

8. *Pseudacris nigrita feriarum* (Baird): Upland chorus frog. ACCOMAC AND NORTHAMPTON COUNTIES: Conant, 1945, as *P. n. triseriata* (Wied).

9. *Rana catesbeiana* Shaw: Bullfrog. ACCOMAC COUNTY: Dunn, 1918; Locustville, Fowler, 1925; Conant, 1945.

10. *Rana clamitans* Latreille: Green frog. ACCOMAC COUNTY: Dunn, 1918; Wallops Island and Locustville, Fowler, 1925; ACCOMAC and NORTHAMPTON COUNTIES: Conant, 1945.

11. *Rana pipiens pipiens* Schreber: Leopard frog. ACCOMAC COUNTY: Chincoteague and Assateague, Fowler, 1925; ACCOMAC AND NORTHAMPTON COUNTIES: Dunn, 1918; Conant, 1945.

12. *Diemictylus viridescens viridescens* (Rafinesque): Newt or eft. NORTHAMPTON COUNTY: Cape Charles, Conant, 1945.

13. *Plethodon cinereus cinereus* (Green): Redback or lead-back salamander. ACCOMAC COUNTY: Conant, 1945; woods near Silva, October 23, 1955, *Reed* 1060; under log south of Wattsville, April 22, 1956, *Reed* 1035–36.

14. *Eurycea bislineata bislineata* (Green): Two-lined salamander, NORTHAMPTON COUNTY: Eastville, Conant, 1945.

15. *Sceloporus undulatus hyacinthinus* (Green): Fence swift. ACCOMAC COUNTY: Wattsville, summer 1953, *Reed*; 6 miles north of Accomac (U.S.N.M. 129523). NORTHAMPTON COUNTY: Dunn, 1918; common on sands and in woods near Kiptopeke, August 1955, *Reed*. ACCOMAC AND NORTHAMPTON COUNTIES: Conant, 1945.

16. *Lygosoma laterale* (Say): Little brown skink. ACCOMAC COUNTY: Woods near Silva on road to Sinnickson, April 22, 1956, *Reed*; woods ½ mile east of Wattsville, female with egg, June 5, 1955, *Reed* 1017. NORTHAMPTON COUNTY: Dunn, 1918; Smith Island (U.S.N.M.).

17. *Natrix sipedon sipedon* (Linnaeus): Common water snake. ACCOMAC COUNTY: Locustville, Wallops Island, Fowler, 1925. NORTHAMPTON COUNTY: Hog Island, Brady, 1925. ACCOMAC AND NORTHAMPTON COUNTIES: Dunn, 1918; Conant, 1945.

18. *Thamnophis sauritus sauritus* (Linnaeus): Eastern ribbon snake. NORTHAMPTON COUNTY: Dunn, 1918; Conant, 1945.

19. *Haldea valeriae valeriae* (Baird and Girard): Eastern ground snake. ACCOMAC COUNTY: Woods near Silva, April 22, 1956, *Reed* 1037. NORTHAMPTON COUNTY: Dunn, 1918; Cobb's Island and Hog Island, Conant, 1945; Hog Island, Fowler, 1925.

20. *Heterodon platyrhinos platyrhinos* Latreille: Hog-nosed snake. ACCOMAC COUNTY: Locustville, Assateague, Wallops Island, Fowler, 1925. NORTHAMPTON COUNTY: Hog Island, Brady, 1925; ACCOMAC AND NORTHAMPTON COUNTIES: Dunn, 1918; Conant, 1945.

21. *Diadophis punctatus punctatus* (Linnaeus): Ring-necked snake. ACCOMAC COUNTY: Chincoteague Island (U.S.N.M. 107667); Conant, Bull. Chicago Acad. Sci. **7**(10): 473–482. 1946.

22. *Coluber constrictor constrictor* Linnaeus: Black racer. ACCOMAC COUNTY: Locustville,

Assateague, Wallops Island, Fowler, 1925; NORTHAMPTON COUNTY: Hog Island, Brady, 1925; ACCOMAC AND NORTHAMPTON COUNTIES: Dunn, 1918; Conant, 1945.

23. *Opheodrys aestivus* (Linnaeus): Rough green snake. ACCOMAC COUNTY: Locustville, Wallops Island, Fowler, 1925. NORTHAMPTON COUNTY: Hog Island, Brady, 1925; ACCOMAC AND NORTHAMPTON COUNTIES: Dunn, 1918; Smiths Island, Conant, 1945.

24. *Elaphe obsoleta obsoleta* (Say): Pilot black snake. NORTHAMPTON COUNTY: Conant, 1945.

25. *Lampropeltis getulus getulus* (Linnaeus): King snake. ACCOMAC AND NORTHAMPTON COUNTIES: Cape Charles. Conant, 1945.

26. *Lampropeltis doliata temporalis* Cope: Coastal Plain milk snake. ACCOMAC COUNTY: Locustville, Wallops Island, Fowler, 1925.

27. *Ancistrodon contortrix mokeson* Daudin: Copperhead. ACCOMAC COUNTY: ½ mile north of Cypress Branch on road to Onancock, July 1955. Illustrated in Onancock newspaper.

28. *Chelydra serpentina serpentina* (Linnaeus): Snapping turtle. ACCOMAC COUNTY: Locustville and Chincoteague, Fowler, 1925; Dunn, 1918. NORTHAMPTON COUNTY: Hog Island, Brady, 1925. ACCOMAC AND NORTHAMPTON COUNTIES: Conant, 1945.

29. *Kinosternon subrubrum subrubrum* (Lacordane): Mud turtle. ACCOMAC COUNTY: Locustville, Chincoteague, Wallops Island, Fowler, 1925: NORTHAMPTON COUNTY: Hog Island, Brady, 1925 (U.S.N.M. 67412–7 and 73256–9); Smiths Island (U.S.N.M. 99029 and 40225–6). ACCOMAC AND NORTHAMPTON COUNTIES: Dunn, 1918; Conant, 1945.

30. *Clemmys guttata* (Schneider): Spotted turtle. ACCOMAC COUNTY: in pitcherplant bog near Wattsville, June 5, 1955, *Reed* 1016; Chincoteague, Fowler, 1925; Dunn, 1918. NORTHAMPTON COUNTY: Hog Island, Brady. (U.S.N.M. 73253–5). ACCOMAC AND NORTHAMPTON COUNTIES: Conant, 1945.

31. *Terrapene carolina carolina* (Linnaeus): Box turtle. ACCOMAC COUNTY: Woods near Wattsville, June 5, 1955, *Reed*; Dunn, 1918. ACCOMAC AND NORTHAMPTON COUNTIES: Conant, 1945.

32. *Malaclemys terrapin terrapin* (Schoepff): Diamondback turtle. ACCOMAC AND NORTHAMPTON COUNTIES: Conant, 1945. NORTHAMPTON COUNTY and Chesapeake Bay: Hog Island, Brady, 1925; Dunn, 1918. (Sometimes called *M. centrata concentrica*.)

33. *Chrysemys picta picta* (Schneider): Painted turtle. ACCOMAC COUNTY: Dunn, 1918; Locustville and Chincoteague, Fowler, 1925. NORTHAMPTON COUNTY: Conant, 1945.

34. *Pseudemys rubriventris rubriventris* (LeConte): Red-bellied terrapin. ACCOMAC COUNTY: Dunn, 1918.

35. *Chelonia mydas mydas* (Linnaeus): Atlantic green turtle. NORTHAMPTON COUNTY: Hog Island (stranded on beach), Brady, 1925; mouth of Chesapeake Bay, January 25, 1893, *J. A. Bully* (U.S.N.M. 51212).

36. *Caretta caretta caretta* (Linnaeus): Loggerhead. NORTHAMPTON COUNTY: "Large numbers caught around Hog Island," Brady, 1925; Chesapeake Bay near Great Wicomico Light House, June 10, 1956, Capt. W. J. Biddlecomb, three specimens caught, one donated by Dr. Clyde F. Reed to the United States National Museum (no. 137572); two other specimens studied and let go.

37. *Dermochelys coriacea coriacea* (Linnaeus): Leatherback turtle. Chesapeake Bay off Great Wicomico Light House, May–June, 1952, Capt. W. J. Biddlecomb. Specimen illustrated in the Richmond News Leader, June 7, 1952, 700 lbs., 7 ft. long, 8 ft. flipper spread, Reed, Journ. Washington Acad. Sci. **47**(1). 1957. ACCOMAC COUNTY: Parramore Island (*F. M. Uhler*); McCauley (The Reptiles of Maryland, 1945); Chesapeake Bay (U.S.N.M. 029492, bones).

38. *Lepidochelys (olivacea) kempi* (Garman): Atlantic ridley. Chesapeake Bay off Great Wicomico Light House, June 10, 1956, Capt. W. J. Biddlecomb, specimen donated by Dr. Clyde F. Reed to the United States National Museum (no. 137573).

The basis of all knowledge is experiment; the very essence of experiments is exactness; and exactness can be obtained only by precise measurements.—J. T. SPRAGUE.

THE AUSTRALOPITHECINES

The major gap between man and his apelike progenitors is bridged by the astoundingly manlike creatures called australopithecines that flourished in South Africa about a million years ago, it is claimed by Dr. Raymond A. Dart of the University of Witwatersrand, Johannesburg, in the Annual Report of the Smithsonian Institution recently issued. Dr. Dart has been one of the major workers in this field since the discovery of the African man-ape skeletal remains a little more than a decade ago. More than a hundred specimens have been found.

These australopithecines, Dr. Dart points out, had "almost human" bodies and brains. They walked erect in human fashion. They improvised and used tools and weapons. Probably, however, they did not have the human faculty of speech. Their brains, as determined from skull capacities, fill the gap between the true apes, such as modern gorilla and chimpanzee, and protohumans, such as the grotesque Neanderthalers of ice age Europe. Dr. Dart says:

> The apparent gap between living apes and living sapient men has been completely bridged by overlapping australopithecine, pithecanthropine [the Java ape-man], and neanderthaline phases of human development. Nothing illustrates this better than brain volume. Although living men generally have fairly large brains, they vary in volume from 790 to 2,350 cc. In other words, a person can still be called a sapient man even when his brain is only one-third the size of his fellows. The living apes' brains, however, vary in volume to a relatively far greater degree: from 87 to 685 cc. . . . Indeed the gap in brain volume between the smallest brained gibbons and the largest brained gorillas is nearly 600 cc., while the gap between the biggest gorilla's brain and the smallest known sapient man's brain is only 105 cc. The gorilla should be more insulted to have his brain compared to that of a gibbon than we should be to have the human brain compared with that of a gorilla. The australopithecine skull capacity varies . . . from 400 to 1,000 cc.; the pithecanthropine-sinanthropine skull capacity . . . . varies from 750 to 1,250 cc.; and the neanderthaline . . . . from 1,250 to 1,600 cc. Therefore, the range of skull capacity in living man overlaps not only that of the extinct neanderthaline and pithecanthropine races of man but even that of some members of the australopithecine race.
>
> We know that *Pithecanthropus* was a primitive man, although his brain volume in some cases was 750 cc., i.e., only 65 cc. bigger than a gorilla's. . . . We know, of course, that there are today and always have been some people in every human race, whether European, Mongolian, or Negro, who are *Homo sapiens* even though their skulls fail to exceed 500 cc. in volume. Nowadays we hide such individuals in asylums and call them abnormal or microcephalic idiots; but that does not change their sapient human ancestry; nor does it prevent them from living and speaking or acting like the sapient human beings they are; or learning to do anything that a very primitive man with a similar brain content, like *Australopithecus*, is likely to have been able to do.

Brain size, Dr. Dart admits, does not necessarily parallel intellectual ability. Investigations during the past few years in one of the major australopithecine sites, the Makapansgat Valley about 200 miles north of Johannesburg, have shown quite clearly that the creatures were adapters and thinkers.

A major distinction between man and lower animals has been the manufacture and use of tools by humans. Hitherto it has been assumed that the earliest artifacts were of crudely fashioned stone. The australopithecines, however, used the teeth and bones of the hyenas and other animals upon which they preyed. Out of these they made clubs, saws, axes, hammers, and many other contrivances essential to their hunting mode of life. Says Dr. Dart:

> These extinct australopithecines had brains about twice as big as those of chimpanzees; more important, they were not semi-erect creatures that built nests of broken branches in the tops of trees like chimpanzees, where they chattered and munched shoots of leaves and fruit. Australopithecines greatly exceeded chimpanzees and gorillas in the use of tools because, along with bigger brains, they had hip bones and a pelvis, thighs, legs, and feet that were in no sense apelike. Their trunk and lower limb bones and muscles were just as human as those in the torso and hips, buttocks and thighs, legs, and feet of Pygmies or Bushmen. They did not spend their lives clambering in trees or swinging from branches, nor did they scamper over the rocks on all fours like baboons; they strode and raced across the veld like men. They did not lollop along supporting a great part of their body weight on their knuckles like chimpanzees and gorillas, when they are on the ground; they marched on their heels and their arms swung free, and customarily they carried in their hands weapons, just as all human beings have carried them since they became upright. Their weapons were not fashioned of stones—they were crude, unshapen clubs, such as were borne by Hercules. They flourished the jawbones

of prehistoric buffaloes, antelopes, zebras, and giraffes, just as Sampson is reputed to have wielded the jawbone of an ass to slay the Philistines. They seized the back ends of antelope skulls as handles and employed their double-pronged horns as picks. . . . They slashed their opponents with antelope hip bones and shoulder blades; they struck them down with tibiae, thigh bones, and upper arm bones. These long bones made excellent bludgeons until their heads were smashed to smithereens by use or their shafts were broken. Then their sword-sharp shattered ends were as formidable as stilettos. Thus armed with implements of bone and horn for striking and thrusting, and tusks of giraffes, baboons, wild bears, hyenas, or saber-toothed tigers for slashing down or slitting open—these weapons torn from the carcasses of beasts slain by themselves or other carnivores—they were just as competent hunters as human beings. . . .

The fossil animals slain by the man-apes . . . . were so big that . . . . I was at first misled into believing that only human beings of advanced intelligence could have been responsible for such manlike hunting work as the bones revealed.

SCENT LANGUAGE OF HONEY BEES

With honey bees it's share and share alike. A single sample of sugar or nectar brought into a hive by a forager is participated in by all the members of a family—all progeny of a single queen—which may number more than 50,000 individuals. Thus all get essentially the same diet, and all acquire a common odor by which they can recognize one another. This odor constitutes a "scent language," which is a basis of the extremely complex bee social life.

These observations, based on experiments with radioactive sugar, are reported by Dr. Ronald Ribbands, of Cambridge University, in the most recent Annual Report of the Smithsonian Institution.

In one of these experiments, Dr. Ribbands says, "a marked bee is trained to collect sugar solution from a small glass tube, and when radioactive sugar is substituted the bee continues to collect the radioactive syrup quite happily. It returns to the hive, and what happens to the labeled sugar can be followed quite easily. Every bee that receives some can be spotted by means of a geiger counter. By collecting a sample of bees from the hive one can discover what proportion of the colony has acquired some of the sugar. We now know that one stomachful can be shared among almost all the bees of a large colony. The experiments indicate that this sharing is a random affair. The sugar is passed on irrespective of the recipient's age or occupation."

This building up of a colony odor through universal sharing of the food supply enables members of the colony to recognize each other. This apparently makes little difference when food is abundant, Dr. Ribbands points out, but becomes of great importance in periods of scarcity.

At those times of the year [he says], when there are insufficient flowers to provide all the bees with food, they often try to steal the honey stored in other colonies. Then the ability to recognize hive mates and to distinguish them from other honey bees will enable a colony to defend itself against attempts at robbery.

However, the honey-bee community does not defend itself by attacking every invader who does not possess the community odor. Strangers are attacked only under certain circumstances. In order to investigate these circumstances, two colonies of differently colored bees were placed close together, with their entrances only 2 inches apart, so that bees often went into the wrong colony by mistake. When good supplies of nectar were available, the intruders were allowed to enter the strange colony, but when nectar was short the strangers were attacked and thrown out, often being killed in the process.

In further experiments, carried out at the end of the season when no nectar could be collected, bees from one of the two colonies were trained to visit dishes filled with sugar solution, but no syrup was made available to bees from the other colony. When this happened I found that the colony whose foragers were collecting syrup would tolerate strangers from the other colony, although these intruders went into it without food. On the other hand, the colony that was not foraging attacked strangers even when they were carrying full loads of the rich sugar solution. This experiment showed that the chance of successful entry was determined by the behavior of the bees of the colony which the intruder tried to enter. The fact that the robbing occurs when foragers are not otherwise employed and that colonies are mostly guarded by unemployed foragers makes this result understandable.

The production of a common and distinctive odor, which enables the colony to defend itself members of other honey-bee communities, is a very important consequence of the habit of food-sharing. Better sharing means better defense, and so a greater likelihood that the community will be able to survive and perpetuate its kind.

The habit plays the key role in the system of communication which enables the new forager to learn about suitable crops, in that the new recruit always received a sample of the crop the colony is working. The first flight becomes a search for a crop with a similar scent. The food-sharing habit enables the worker bees in a colony to be apprised of the presence of their queen. A substance derived from her body is conveyed from bee to bee in the shared food, and in the event of any deficiency in the substance they take steps to rear another queen. In addition, it probably helps to ensure an effective division of labor in the colony, which has to be so integrated that a suitable proportion of the worker population carries out each of the various tasks necessary for maintenance of the colony.

REVERSAL OF PARITY LAW IN NUCLEAR PHYSICS

Recent low-temperature experiments at the National Bureau of Standards have demonstrated that the quantum mechanical law of conservation of parity does not hold in the beta decay of cobalt-60 nuclei.[1] This result, together with experiments on parity conservation in μ-meson decay at Columbia University's Nevis Cyclotron Laboratories, shatters a fundamental concept of nuclear physics that has been universally accepted for the past 30 years. It thus clears the way for a reconsideration of current physical theories with the possibility of new, far-reaching discoveries regarding the nature of matter and the universe.

In particular, removal of the restrictions imposed by parity conservation promises to bring order to the theoretical chaos now existing in regard to subatomic particles. It is generally held that the new "elementary" particles from proton accelerators are manifestations of the forces that bind the nucleus together. Thus, a better understanding of these particles may well lead to a more fundamental, unifying theory of the nature of matter and energy.

The beta-decay experiments were carried out by C. S. Wu of Columbia University and NBS staff members Ernest Ambler, Raymond W. Hayward, Dale D. Hoppes, and Ralph P. Hudson. The Bureau's low temperature laboratory was chosen for the experiments because of its previous experience in low-temperature alignment of atomic nuclei,[2] an essential feature of the beta-decay study.

Basically, parity conservation in quantum mechanics means that two physical systems, one of which is a mirror image of the other, must behave in identical fashion except for the mirror image effect. In other words, nature is symmetrical and makes no fundamental distinction between right- and left-handed rotations or between the opposite sides of a subatomic particle. Thus, for example, two similar radioactive particles spinning in opposite directions about the same axis should emit the same intensity of radioactivity in any given direction. Neither the right- nor the left-handed rotation should be favored by a greater intensity of emission so long as parity is conserved.

Since 1925 physicists have accepted the principle that parity is conserved in all types of interactions. During the past few years, however, phenomena have been described in high-energy physics that could not be explained by existing theories. Large accelerators such as the Cosmotron and Bevatron have been producing a variety of subatomic particles whose behavior has defied systematic analysis. One such particle is the K meson, a short-lived particle which the proton beam ejects from atomic nuclei. Although K mesons are alike in all significant ways, some of them decay into three π mesons while others decay into only two π mesons. Mathematically this inconsistent behavior led to the suspicion that an explanation might be found in a violation of the principle of conservation of parity.

In the summer of 1956 T. D. Lee of Columbia University and C. N. Yang of the Institute for Advanced Study made a survey[3] of experimental information on the question of parity. They concluded that the evidence then existing neither supported nor refuted parity conservation in the

[1] For further details, see *An experimental test of parity conservation in beta decay*, by C. S. Wu, E. Ambler, R. W. Hayward, D. D. Hoppes, and R. P. Hudson, Phys. Rev. (in press).

[2] *Low-temperature alignment of radioactive nuclei*, NBS Tech. News Bull. **40:** 49. April 1956. See also, Ambler, E., Hudson, R. P., and Temmer G. M., Phys. Rev. **97:** 1212. 1955; and **101:** 1096. 1956.

[3] Lee, T. D., and Yang, C. N. Phys. Rev. **104:** 254. 1956.

so-called "weak interactions", such as emission of a beta particle or K-meson decay. They also proposed a number of experiments on beta decays and hyperon and meson decays that would provide the necessary evidence for or against parity conservation in weak interactions. One of the proposed experiments involved measuring the directional intensity of beta radiation from oriented cobalt-60 nuclei. At the suggestion of Professor Wu of Columbia, arrangements were made to carry out this experiment in the Bureau's low temperature laboratory.

Polarization of the nuclei was achieved by cooling a paramagnetic crystal containing cobalt-60 to within 0.01°C. of absolute zero, and subjecting it to a magnetic field. At this temperature the effects of thermal agitation are so small that atomic nuclei can line up in a given direction within the crystal lattice when a magnetic field is applied.

The magnetic polarity of the nucleus is determined by its direction of spin, and, under the influence of a magnetic field, most of the cobalt-60 nuclei align themselves so that their spin axes are parallel to the field.

As cobalt-60 is radioactive, its nuclei continuously emit beta and gamma rays. If parity is conserved in such interactions, then the intensity of the beta emission should be the same in either direction along the axis of spin. This, of course, was the critical question in the cobalt-60 experiments. It was resolved by measuring the intensity of beta emission in both these directions, i.e., along and against the field direction.

The cobalt-60 was located in a thin (0.002-inch) surface layer of a single crystal of cerium magnesium nitrate. The crystal was placed in an evacuated flask which in turn was immersed in liquid helium within a Dewar flask surrounded by liquid nitrogen. An inductance coil on the surface of the inner flash was used to measure the temperature of the crystal in terms of its magnetic susceptibility.

A major experimental problem was the location of a radiation counter within the evacuated flask for detection of beta particles. This problem was solved by placing a thin anthracene crystal inside the chamber to serve as a scintillation counter. The anthracene crystal was located about 2 cm above the cobalt-60 source. Scintillations caused by beta particles striking the crystal were transmitted through a glass window and a 4-foot lucite rod acting as a light pipe to a photomultiplier at the top of the flask. The resulting pulses were counted on a 10-channel pulse-height analyzer.

In addition to the beta counter within the vacuum chamber, two sodium iodide gamma scintillation counters were used externally to measure the directional intensity of the more penetrating gamma radiation. In this way the investigators were able to determine the degree of polarization of the cobalt-60 nuclei. The two gamma counters were biased to accept only the pulses from the photopeaks in order to discriminate against pulses from Compton scattering.

Cooling to the low temperature necessary for nuclear alignment was accomplished by the process of adiabatic demagnetization using a magnetic field of about 23,000 oersteds. This process involved successive magnetization and demagnetization of the paramagnetic salt, cerium magnesium nitrate, which supported the cobalt-60 specimen. The heat produced by magnetization was removed by the boiling off of liquid helium in the surrounding dewar. The specimen was then thermally isolated and upon demagnetization the temperature fell to about 0.003°K.

A vertical solenoid was then raised around the lower end of the outer dewar to provide a magnetic field for polarization of the cobalt-60 nuclei. After the beta emission had been measured for this condition, the direction of the magnetic field was reversed, and the beta emission again measured for nuclei polarized in the opposite direction. It was found that the emission of beta particles is greater in the direction opposite to that of the nuclear spin. Thus, a spinning cobalt-60 nucleus has a beta emission distribution that is not the same as that of its mirror image. This result unequivocally demonstrates that parity is not conserved in the emission of beta particles by cobalt-60.

According to the theoretical studies of Professors Lee and Yang, the present experiment indicates not only that conservation of parity is violated in beta decay, but also that invariance under charge conjugation is violated.[4] This can be interpreted to mean that when the algebraic signs of all electric charges in a physical system are changed, the physical behavior of the system may not always remain unaltered. Most re-

[4] LEE, T. D., OEHME, REINHARD, and YANG, C. N. Phys. Rev. (in press).

cently, Lee and Yang have developed a new theory for the neutrino as a result of the foregoing work.[5]

[5] LEE, T. D., and YANG, C. N. Phys. Rev. (in press).

Further low-temperature studies of beta decay are proceeding at the bureau. In this work it is hoped that the invariance of time reversal—changing the algebraic sign of time in time-space equations—can be decided.

GUAYMÍ "MEDICINE"

"Medicine" is the supreme secret among the Guaymí Indians of Panama. Healing practices are guarded more zealously than the whereabouts of gold, and even the most welcomed outsiders are told nothing. This was the case with the Reverend Ephraim S. Alphonse, for many years a Wesleyan Methodist missionary among these people. However, after years of observation, Mr. Alphonse is able to describe a few of the practices in a grammar and vocabulary just published by the Smithsonian Institution. The descriptions will cause little enthusiasm among American physicians, although some of the treatments may be based on sound psychology.

For a pain in any part of the body a "pain diversion" therapy is used by the Guaymí medicinemen—that is, they relieve the suffering by causing a more severe pain in the same part.

Toothache, for example, is treated by attaching a nail to a bit of wood, heating it red hot, and then briskly touching the parts around the affected tooth nine or ten times. The same is done for gallstones or pains in the liver or spleen. When there is a swelling in which there is pus, the red-hot nail is thrust in until the pus drains out. The treatment is quite effective. "The wound generally heals in a few days," Mr. Alphonse observed.

Certain sores, like those of yaws, are smoked. A hole is dug in the ground, the nest of a colony of wood termites is broken and put in, and a fire is set. This gives off a heavy smoke which rises for hours. An affected leg is held over this smoke for a whole day while the patient lies prostrate. The cure, Mr. Alphonse says, usually works so far as the sore is concerned.

When a man dies his body is handled by specially appointed persons, the "mubai." The body is wrapped in cloth and with it are placed the weapons used in hunting. The bow and arrows, clothes, and a drinking gourd of the dead man are put on the grave. The mourners are supposed to weep aloud every morning from 5 to 6 o'clock for nine days. When those who dig the grave and bury the body return home they change their clothes at the village watering place, bathe, and wash their hands with a scented concoction from a plant known as "culantro." Then they may return to their homes, but the hut from which the body was taken is abandoned for a long time.

If a snake bites a man, the missionary relates, after various preliminary treatments a bush that has the color of the snake is boiled, and the brew is given the victim to drink until he recovers. Before that, however, these preliminaries are necessary:

The victim must not be touched or seen by either a pregnant woman or her husband. If the snake is killed the head is cut off and burned, and the ashes are mixed with gunpowder. The patient eats this mixture after swallowing whole the gall of the serpent. The wound is opened with a knife, gunpowder is put in, and a match applied. "To kill a really bad snake," Mr. Alphonse relates, "tobacco is chewed to an odorous paste, wrapped in a thin leaf, and put on the end of a long stick. With this the snake is teased until it snaps at the tobacco. Instantly it is paralyzed and can be handled with the bare hands."

Knowledge of herbs is handed down from father to son. When a medicineman dies, a relative whom he has instructed steps into his place after a period of mourning. Eventually a case comes up to test the skill of this relative. If he effects a cure, his fame spread and he encourages this with boasts of spiritual revelations. Once both fear and confidence are inspired, his practice is established.

Twin babies, Mr. Alphonse says, forebode evil to their parents. The only way to offset this is to cause one to die. This is usually done at birth, but at times one of the babies is allowed slowly to perish.